CLAIMS

What is claimed is:

1. A film bulk acoustic resonator formed on a substrate, the film bulk acoustic resonator comprising:

a layer of piezoelectric material including:

a first surface proximate the substrate;

a second surface distal from the surface of the substrate;

a first conductive layer including a portion in contact with the first surface of the layer of piezoelectric material, the first conductive layer being nonplanar ; and

a second conductive layer in contact with the second surface of the layer of piezoelectric material.

2. The film bulk acoustic resonator of claim 1 wherein the first conductive layer and the second conductive layer are deposited on the first surface and second surface of the layer of piezoelectric material.

3. The film bulk acoustic resonator of claim 1 wherein the layer of piezoelectric material is a single-crystal film.

4. The film bulk acoustic resonator of claim 3 wherein the layer of piezoelectric material is AlN.

5. The film bulk acoustic resonator of claim 3 wherein the layer of piezoelectric material is ZnO.

6. The film bulk acoustic resonator of claim 3 wherein the layer of piezoelectric material is a C-axis orientated film.

7. The film bulk acoustic resonator of claim 1 wherein the layer of piezoelectric material includes:

a C-axis oriented portion; and

a non C-axis oriented portion, wherein at least a portion of the first conductive layer and a portion of the second conductive layer is proximate the C-axis oriented portion of the layer of piezoelectric material.

8. The film bulk acoustic resonator of claim 1 wherein the first conductive layer includes:

a first planar portion; and

a second planar portion, the first planar portion and the second planar portion having surfaces in different planes.

9. A method for forming a device in a substrate comprising:

depositing a first portion of a first electrode onto the substrate;

depositing a piezoelectric layer on the substrate and a portion of the first portion of a first electrode, the piezoelectric film layer having a first surface proximate the substrate and a second surface remote from the substrate;

placing a second electrode on the second surface of the piezoelectric layer;

removing a portion of the substrate under the piezoelectric layer and under the portion of the first electrode; and

depositing a second portion of the first electrode onto the first surface of the piezoelectric film layer and onto the first portion of the first electrode.

10. The method of claim 9 wherein the piezoelectric layer is a single crystal piezoelectric film.

11. The method of claim 9 further comprising removing a portion of the first surface of the piezoelectric layer.

12. The method of claim 11 further comprising removing a portion of the first portion of the first electrode.

13. The method of claim 9 further comprising placing the second portion of the first electrode in electrical contact with the first portion of the first electrode.

14. A method for forming a device in a substrate comprising:

placing a first portion of a first electrode onto the substrate;

placing a piezoelectric layer on the substrate and on a portion of the first portion of the first electrode, the piezoelectric layer having a first surface proximate the substrate and a second surface remote from the substrate;

placing a second electrode on the second surface of the piezoelectric layer;

removing a portion of the substrate under the piezoelectric layer and under the portion of the first electrode;

placing a second portion of the first electrode onto the first surface of the piezoelectric film layer and onto the first portion of the first electrode.

15. The method of claim 14 further comprising the step of placing a seed layer onto the substrate.

16. The method of claim 15 wherein the seed layer is non-conductive.

17. The method of claim 14 further comprising removing a portion of the first surface of the piezoelectric layer.

18. The method of claim 15 further comprising removing a portion of the seed layer under the piezoelectric layer and under the portion of the first electrode.

19. The method of claim 15 wherein the seed layer is a single crystal seed layer.

20. The method of claim 15 wherein the seed layer is capable of growing a single crystal piezoelectric film.

21. The method of claim 15 wherein the seed layer is conductive.

22. The method of claim 21 further comprising removing a portion of the first surface of the piezoelectric layer.

23. A method for forming a device in a substrate comprising:

depositing a dielectric layer onto the substrate;

depositing a seed layer onto the dielectric layer;

depositing a first portion of a first electrode onto the dielectric layer;

depositing a piezoelectric layer on the dielectric layer and on a portion of the first portion of the first electrode, the piezoelectric layer having a first surface proximate the substrate and a second surface remote from the substrate;

placing a second electrode on the second surface of the piezoelectric layer;

removing a portion of the substrate under the piezoelectric layer and under the portion of the first electrode;

removing a portion of the dielectric layer under the piezoelectric layer and under the portion of the first electrode;

removing a portion of the seed layer under the piezoelectric layer and under the portion of the first electrode;

depositing a second portion of the first electrode onto the first surface of the piezoelectric film layer and onto the first portion of the first electrode.

24. The method of claim 23 wherein the seed layer is non-conductive.

25. The method of claim 24 further comprising removing a portion of the first surface of the piezoelectric layer.

26. The method of claim 23 wherein the seed layer is conductive.

27. The method of claim 26 further comprising removing a portion of the first surface of the piezoelectric layer.

28. The film bulk acoustic resonator of claim 1 the substrate includes an opening therein, the film bulk acoustic resonator positioned over the opening in the substrate.

29. A film bulk acoustic resonator device formed on a substrate having an opening therein, the film bulk acoustic resonator comprising:

a seed layer exposed about the periphery of the opening; and

a layer of piezoelectric material spanning the remaining portion of the opening.

30. The film bulk acoustic resonator device of claim 29 wherein the opening has a larger area near the layer of the piezoelectric material and a smaller area remote from the piezoelectric material.

31. The film bulk acoustic resonator device of claim 29 wherein the substrate further includes a major surface, the opening further including at least one sidewall, the angle between the at least one sidewall and the major surface of the substrate at an angle other than perpendicular.

32. The film bulk acoustic resonator device of claim 29 wherein the seed layer is in a first plane and the layer of piezoelectric material is in a second plane.

33. The film bulk acoustic resonator device of claim 29 further including a conductive layer.

34. The film bulk acoustic resonator device of claim 33 wherein the seed layer is in a first plane, the layer of piezoelectric material is in a second plane, and at least a portion of the conductive layer is in a first plane.

35. The film bulk acoustic resonator device of claim 29 further comprising:

a first conductive layer; and

a second conductive layer, the first conductive layer deposited on a first surface of the piezoelectric material, and the second conductive layer deposited on a second surface of the layer of piezoelectric material.

36. The film bulk acoustic resonator device of claim 35 further comprising:

a first electrode; and

a second electrode, wherein the first conductive layer is a portion of the first electrode, and the second conductive layer is a portion of the second electrode.

37. The film bulk acoustic resonator device of claim 36 wherein at least one of the first electrode, and the second electrode has portions which are in different planes.

38. The film bulk acoustic resonator device of claim 36 wherein both the first electrode, and the second electrode have portions which are in different planes.

39. The film bulk acoustic resonator of claim 29 wherein the layer of piezoelectric material is a single-crystal film.

40. The film bulk acoustic resonator of claim 29 wherein the layer of piezoelectric material is AlN.

41. The film bulk acoustic resonator of claim 29 wherein the layer of piezoelectric material is ZnO.

42. The film bulk acoustic resonator of claim 29 wherein the layer of piezoelectric material is a C-axis orientated film.

43. The film bulk acoustic resonator of claim 29 wherein the layer of piezoelectric material includes:

a C-axis oriented portion; and

a non C-axis oriented portion, wherein at least a portion of the first conductive layer and a portion of the second conductive layer is proximate the C-axis oriented portion of the layer of piezoelectric material.

44. The film bulk acoustic resonator of claim 29 wherein the seed layer is nonconductive.

45. A film bulk acoustic resonator device formed on a substrate having an opening therein, the film bulk acoustic resonator comprising:

a seed layer of non conductive material; and

a layer of piezoelectric material contacting the seed layer of non-conductive material.

46. The film bulk acoustic resonator of claim 45 wherein the seed layer also has an opening therein that corresponds to the opening in the substrate, the opening in the seed layer including a layer of conductive material.

47. The film bulk acoustic resonator of claim 46 wherein the conductive material within the opening in the seed layer is a portion of a first electrode associated with a first surface of the layer of piezoelectric material.

48. The film bulk acoustic resonator of claim 47 further comprising a second electrode associated with a second surface of the layer of piezoelectric material.

49. The film bulk acoustic resonator of claim 48 further comprising a source of RF voltage attached between the first electrode and the second electrode.